REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From - To)*
02-10-2014	Final	

4. TITLE AND SUBTITLE
Test Operations Procedure (TOP)
02-2-506A Wheeled and Tracked Vehicle Endurance Testing

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHORS

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Aberdeen Test Center
400 Colleran Road
Aberdeen Proving Ground, MD 21005-5059

U.S. Army Yuma Proving Ground
301 C. Street
Yuma, AZ 85365-9498

8. PERFORMING ORGANIZATION REPORT NUMBER
TOP 02-2-506A

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Test and Evaluation Command
CSTE-TM (Range Infrastructure Division)
2202 Aberdeen Boulevard
Aberdeen Proving Ground, MD 21005-5001

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
Same as item 8

12. DISTRIBUTION/AVAILABILITY STATEMENT

Distribution Statement A. Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES
Defense Technical Information Center (DTIC), AD No.:

This TOP supersedes TOP 02-2-506, Endurance Testing of Tracked and Wheeled Vehicles, dated 26 June 1981

Marginal notations are not used in this revision to identify changes, with respect to the previous issue, due to the extent of the changes.

14. ABSTRACT
This document describes procedures for conducting endurance tests of wheeled and tracked vehicles over various standard test courses for prescribed distances or times. Endurance testing involves extended operation of one or more test vehicles under cycles designed to simulate extended field use under proving ground conditions. The endurance test is the principle means of producing data for reliability and maintainability during development tests.

15. SUBJECT TERMS
Availability Maintainability Endurance Tests Durability Reliability Test Courses Human Factors

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**B. ABSTRACT**	**C. THIS PAGE**			**19b. TELEPHONE NUMBER** *(include area code)*
Unclassified	Unclassified	Unclassified	SAR	38	

(This page is intentionally blank.)

U.S. ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

*Test Operations Procedure 02-2-506A 2 October 2014
DTIC AD No.

ENDURANCE TESTING OF TRACKED AND WHEELED VEHICLES

*This TOP supersedes TOP 02-2-506, Endurance Testing of Tracked and Wheeled Vehicles, dated 26 June 1981.

1. SCOPE.

a. This Test Operations Procedure (TOP) provides procedures for conducting endurance tests of military tracked and wheeled vehicles over various standard test courses for a prescribed distance or number of operating hours. An endurance test is conducted to produce data for the reliability, availability, maintainability, durability, human factors, safety, and environmental suitability evaluations for test vehicles.

b. This is the primary phase of developmental testing which provides information for evaluation of the suitability of the vehicle, onboard weapons, or installed equipment to perform for extended periods in conditions representative of actual worldwide military operating environments. Because of this, it is beneficial that tests be conducted under controlled conditions which represent the primary anticipated operational environments (Temperate, Desert, Cold Regions, and Tropics) under climatic conditions and on terrains characteristic of those environments. The U.S. Army Aberdeen Test Center (ATC), Maryland, is the Temperate Zone test site while the U.S. Army Yuma Test Center (YTC) at Yuma Proving Ground (YPG), Arizona, is the Desert/Hot Weather test site. YPG also serves as the point of contact for arranging testing at the Cold Regions and Tropic Test Centers. This TOP only contains test courses for the test sites that currently have recognized endurance test courses (ATC and YPG).

c. Controlled testing on characterized and representative terrains is important to not only isolate environmentally caused failures or performance shortfalls, but to also ensure test to test repeatability as subsequent system improvements are made, new production sources come on line or alternative vehicles (e.g,. commercial off the shelf (COTS) or foreign substitutes) are acquired. The endurance test should be conducted as closely as possible to the operational mission environments in which the vehicle is expected to operate. To achieve this goal, the vehicle should be operated and maintained by personnel with skill, training, and experience levels that are representative of those of the expected user. Test scenarios of typical operational missions, to include weapons firing and functional checkouts of onboard installed subsystems, and associated support in other equipment (ASIOE), should be included in the endurance test design.

d. For clarification purposes, the following are definitions of two terms typically associated with this type of testing:

(1) An endurance test is a test which involves extended operation of one or more test items operating a series of cycles designed to simulate extended field use, under controlled, repeatable proving ground conditions. The endurance test is the principal means of producing data for reliability and maintainability during developmental tests, and also is a major source of information on human factors, safety, and environmental effects.

(2) A durability test is designed to demonstrate a specified probability and confidence that a vehicle, or a major component thereof, will be able to operate under defined conditions for a specified distance or operating hours before requiring major overhaul, replacement, or salvage. An accumulation of the test cycles prescribed in this TOP for endurance testing usually constitutes a durability test (see guidance in TOP 01-2-502[1**]).

2. FACILITIES AND INSTRUMENTATION.

2.1 Facilities.

Select appropriate test courses to satisfy the system Operational Mode Summary/Mission Profile (OMS/MP), or if one is not available, use a mission profile from those described in paragraph 5.1. ATC and YPG test courses are described in detail in TOP 01-1-011A[2].

2.2 Instrumentation.

Select instrumentation appropriate to the test being conducted and the test item being operated. Instrumentation generally used for Endurance testing would be a type of Data Acquisition (DAQ) system that can record data such as, but not limited to: distance, vehicle speed, vehicle acceleration (vertical, lateral, and longitudinal and roll, pitch, and yaw), engine speed, engine hours, vehicle voltage, suspension displacement, suspension acceleration, critical temperatures and pressures, and other vehicle-specific component parameters (e.g., master power hours, turret power hours, etc.). For any type of instrumentation being utilized, list the type of DAQ system, the calibration date, parameters to be recorded, measurement units, and permissible tolerances associated with those parameters. If applicable, data can be collected utilizing the vehicle's controller area network bus (CANBUS). Consult the customer (e.g., Program/Product Manager, materiel developer, AEC Test Manager/Evaluators, etc.) regarding instrumentation requirements.

3. REQUIRED TEST CONDITIONS.

3.1 Test Planning.

a. Develop an endurance or reliability, availability, maintainability, durability (RAM-D) subtest, and separate integrated logistics supportability (ILS) subtest. Establish in the endurance subtest, the test courses that will be used, the mix of test courses for each test cycle with mileage on each course, and the hours/cycles of operation for ancillary and mission equipment. The equipment tests may include winches, material handling equipment, load handling equipment, trailer coupling/uncoupling, turret operations, weapons firing, communications, on-board power, and lift/tow (wreckers) to identify equipment damage or degradation. When establishing test mileage cycles, identify the number of vehicles, vehicle payload and towed load configurations, and the mileage required for each configuration. Identify vehicle performance and operating parameters which need to be quantified during testing and select instrumentation appropriately.

** Superscript numbers correspond to Appendix D, References.

Develop the RAM-D and ILS subtests with guidance from TOP 01-1-030[3]. Prepare the procedures that will be used to evaluate RAM-D criteria, and if none are provided, consult the materiel developer. The subtest should explain how to evaluate the test item for its effective usability, maintenance needs and methods, ability to withstand extended real world use, and ability to support and maintain the test item for its usable life.

b. All endurance, RAM-D, and ILS subtests should be created based on the guidance and agreement of the U.S. Army Test and Evaluation Command (ATEC) System Team (AST), the Test Sponsor, and the test center Test Officer. All endurance subtests created should be in accordance with a vehicle's OMS/MP, if one is available.

Note: Much of the data for the logistics supportability parameters will be derived from the scheduled and unscheduled maintenance actions performed during the endurance testing (repair time, parts usage, adequacy of special tools, ease of maintenance, safety issues). However, additional details are needed to address special conditions for the test, e.g., whether or not simulated maintenance actions will be conducted, how ancillary equipment and mission equipment maintenance will be presented (separate or combined with the basic vehicle), and how scheduled maintenance actions will be adjusted if designated by a time interval that would be accelerated by the testing.

3.2 Facilities.

Identify the test courses used by name and location (TOP 01-1-011A). Provide a description of the test course to include guidance contained in TOP 01-1-010[4] and include details such as soil type, course contour, length and degree of grades, course length, surface description, and roughness in terms of wave number spectrum.

3.3 Test Item.

3.3.1 Initial Inspection and Lubrication.

Upon asset arrival, obtain an initial weight, and an odometer and/or engine/system hour meter reading(s). Take characteristic photographs of the original, received, and final test configurations. Initially inspect and lubricate the test vehicle as necessary to ensure that all components function satisfactorily; see guidance in TOP 02-2-505[5]. The inspection usually is limited to a visual and functional inspection of the test item. As a minimum, the items normally addressed during a semi-annual preventive maintenance checks and services (PMCS), or the items in the "Services Upon Receipt" section as described in an applicable Technical Manual (TM), should be visually inspected and checked for functionality. The initial inspection can be expanded to include more details when doubt exists concerning the serviceability of the test asset. Verify the vehicle odometer is accurate by driving the vehicle over a known distance. If the odometer is suspect, consider installing a hub odometer or fifth wheel device (if applicable) for more accurate measurements. Similarly, consider adding a time keeping device if the hours meter is suspect. Consult the test sponsor for any specific inspection requirements, critical areas to be inspected, and past service and usage history of the vehicle. Record the model and serial numbers of the vehicle and major components. Using guidance from TOP 02-2-704[6], check the

test item's tire condition, tire pressures, record tire information, and measure the tread depths. Ensure that the test item's tire pressures are stenciled on the vehicle above each wheel and tire assembly location. Check lubricant types against specifications and record deviations. This information is particularly significant for experimental or foreign vehicles since little is known of the material used for seals and bearings. Collecting fluid samples, for spectrometric analysis of the initial lubricants (see guidance in TOP 02-2-690[7]), may help to identify the type used and provide baseline data for future spectrometric analysis for contaminants. Identify the type(s) of fuel or gas required by the test item and stencil it near, or on, the fuel/gas cap. Perform maintenance and service operations to insure that the vehicle is in condition for optimum performance. Give particular attention to engine, transmission and running gear. Generate an individual Test Incident Report (TIR) for each anomaly found during the initial inspection.

3.3.2 Break-In Operation.

Operate new vehicles for the appropriate break-in as described in the applicable TM. If no break-in procedure is contained in the TM, consult with the customer. If TMs are not written when the test is conducted, consult the material developer to see if the vehicle manufacturer intends to include a break-in procedure in the TM once they are written, and then have the material developer provide that break-in procedure for use. Document the break-in procedure used in a TIR.

3.3.3 Test Loads.

a. When possible, load each vehicle with the cargo it is designed to carry or with a simulated payload (e.g., a dump truck hauls gravel, sand, or crushed stone). To simulate a vehicle's interior equipment, use replicated items to suit the test item's mission. Load combat vehicles with dummy ammunition and load personnel carriers with weights to simulate crew. A vehicle's basic issue items (BII) should be inventoried and properly stowed on the vehicle. If the BII are not available for testing, use mass simulators in the location(s) where the BII would be stowed. Water dummies can be used to simulate occupants to be placed into the vehicle seats. If accurate payload guidance does not exist in applicable TMs, consult with the vehicle manufacturer, AST, or with Military Standard (MIL-STD)-1366E[8]. When it is not practical to replicate the actual vehicle payload, payload simulators should be used which replicate system representative payloads with respect to overall weight and center of gravity. Materials selected for simulated loads should neither strengthen nor weaken the test vehicle structure artificially. Secure loads adequately to prevent shifting, and instruct the drivers concerning special hazards. Simulated payloads that are added into the interior of a vehicle should follow the ATC Internal Operating Procedure (IOP) 385-0010[9]. This will ensure that the payload is properly engineered and safely installed into a vehicle.

b. Vehicles that carry a load other than personnel, BII, and other installed equipment should perform endurance testing with multiple load configurations. For example, a truck tractor performing developmental testing should be tested without a trailer, towing an empty trailer, and towing a fully loaded trailer. This will expose the truck tractor to the three main modes in which it would encounter with the end user. Similar guidance can be applied to the vehicle load (interior personnel and equipment, and cargo loads) as well. The Test Officer, Test

Sponsor/Vehicle Manufacturer, and AST should agree on the different load configurations and the percentage of mileage each should be tested. As applicable, when a towed load is introduced, consideration should be taken to ensure the additional weight from the towed load onto the hitch/pintle of the prime mover does not exceed the prime mover's tow, axle, and weight ratings. An overload scenario of the prime mover should only be allowed if a waiver from the Program/Product Manager office of the prime mover is obtained to concur that it is acceptable and safe to overload the prime mover. Furthermore, the test customer/AST must accept the risk when testing in an overload situation.

3.3.4 Test Personnel.

a. Select an appropriate number of test drivers/crew from a pool of qualified personnel based upon the miles to be driven, the number of test vehicles, and the number of experienced personnel available. Train appropriate personnel (e.g., drivers, mechanics, data collectors, etc.) in the operation, PMCS, and maintenance of the test item utilizing the pertinent TMs, training manuals, or other appropriate documents. Whenever possible, operators and maintainers should be trained by the provided manufacturer's new equipment training (NET) package. NET will provide the operators and maintainers with the same level of training as the end user and the adequacy of the NET can be evaluated.

b. If military personnel are required, ensure a Test Schedule and Review Committee (TSARC) request is submitted within one year from the start of testing or as early as possible. A Safety Release (SR) must be obtained from the U.S. Army Evaluation Center (AEC) prior to using military personnel as test participants.

3.3.5 Safety and Health Evaluation.

Before starting an endurance test, review the Safety Assessment Report (SAR) and conduct those tests necessary to establish a reasonable assurance that the test item can be tested with a minimum risk to personnel (e.g., human factors and toxic fumes on prototype and new vehicles and/or vehicles with new engines/emissions controls). Guidance in TOP 02-2-508[10] should be consulted for a description of these tests that may be required to adequately evaluate safety and health aspects of the test vehicle. The results of the safety and health evaluation are used as recommended input to the AEC safety release or safety confirmation. Generate an individual TIR for each anomaly found during the safety and human factors evaluation.

3.3.6 Data Required.

Record the following during preparation for test:

a. Test course identification and test cycle description.

b. Description of how ancillary equipment will be tested and number of hours, cycles, or rounds fired.

c. Instrumentation types, locations, and calibration data.

d. Vehicle and major component serial numbers.

e. Test item identification number (TIIN).

f. Tire pressures (if applicable).

g. Tread depth measurements (if applicable).

h. Suspension configurations (if applicable).

i. Payload weight and configuration, prime mover and trailer/towed load, as applicable.

j. Break-in mileage (if applicable).

k. Training method.

l. Listing of all TIRs generated.

m. Software version(s) (if applicable).

4. TEST CONTROLS.

a. Observe all safety Standing Operating Procedures (SOPs) throughout test operations.

b. Maintain correct levels of standard military lubricants, hydraulic fluids, coolants, etc., in the test vehicle. Unless otherwise required, operate all vehicles with JP-8 or F-24 as fuel.

c. Record meteorological conditions including temperature, relative humidity, winds, precipitation, and general weather conditions (e.g., rain, muddy, snow, etc.) for all periods of operation.

d. If feasible, to limit the influence of individual driving habits on test results, rotate the available drivers among test vehicles according to a predetermined schedule so each driver will operate each vehicle for a comparable proportion of the total test mileage for each course, to the extent possible.

e. Maintain the severity level of the courses as constant as possible throughout testing using the procedures described in TOP 01-1-010. Test courses will represent the types of surfaces discussed in paragraph 5.1.1 and include both level and hilly terrain. The courses will be characterized as to soil types, general hardness/softness, etc., in addition to being profiled for severity (relative smoothness) levels.

f. Army Regulation (AR) 70-38[11] requires that all equipment intended for use by Army forces must perform within the temperature range of -32 to 43 °Celsius (C) (-25 to 110 °Fahrenheit (F)). Endurance testing of vehicles should include extended operations over this

range of temperatures and the associated climatic effects (e.g., rain, mud, freezing rain, sandy and rocky terrain, heat, dust, low temperatures, snow and ice covered terrain). Endurance testing should be conducted so as to expose a vehicle and related systems to conditions representative of the mission profile.

g. Corrosion protection is a constant challenge for Army materiel wherever deployed. Coastal areas in Temperate and Tropic regions can provide corrosive environments. If applicable, endurance test cycles should include corrosion testing following guidance in TOP 01-1-065[12].

5. TEST PROCEDURES.

5.1 Method.

Endurance testing should follow guidance given in a vehicle's OMS/MP. If a vehicle will not be tested in accordance with an OMS/MP, or one has not been established, the vehicle categories and descriptions are provided below to identify an Endurance Testing profile. Weights are provided for guidance. If uncertainty exists, consider the intended mission of the vehicle as the primary qualifier. Choose which category best describes the vehicle. This category will correspond to an Endurance Testing profile in Table 1. Each vehicle type has a recommendation, by terrain type, for the percentage of mileage for each test course in Appendix A, Table A-1.

TABLE 1. SAMPLE VEHICLE MISSION PROFILES, PERCENTAGE

VEHICLE TYPE	PRIMARY	SECONDARY	TRAILS/ROUGH TRAILS	CROSS COUNTRY
Wheeled Light	30	30	20	20
Wheeled Medium	20	50	15	15
Wheeled Heavy	30	50	10	10
Mine Resistant Ambush Protected (MRAP) / Route Clearance Vehicle (RCV)	10	40	30	20
Wheeled Truck-Tractor and Trailer, Light and Medium	50	40	10[a]	-
Wheeled Truck-Tractor and Trailer, Heavy	40	45	15[a]	-
Motorcycle	10	10	50	30
Quad / All Terrain Vehicle (ATV)	10	10	50	30
Fire Trucks - Crash and Rescue, Brush, Structural	49/56/50	22/16/50	-	29/28/0[a]
Wheeled Combat	30	40	15	15
Robotic[b]	-	30	50	20
Tracked Combat[c]	32.4	32.2	-	35.4[a]
Tracked Combat Support[c]	32.4	32.2	-	35.4[a]

TABLE 1. CONTINUED

VEHICLE TYPE	PRIMARY	SECONDARY	TRAILS/ROUGH TRAILS	CROSS COUNTRY
Tracked Engineering - Steel Tracked	13	-	37[d]	50
Tracked Engineering - Rubber Tracked	20	-	45[d]	35
Engineering	55	-	35[d]	10
Material Handling	35	-	50[d]	15

[a] Mileage can be divided between trails and cross country if necessary.
[b] Tentative mission profile for Self Transportable Force Application only. Subject to change.
[c] Terrain percentages and mileage breakdowns (Table A-1) are dependent on test requirements, mission, and vehicle types.
[d] Mileage can be divided between trails and secondary if necessary.

a. Wheeled Light: Wheeled vehicles with a gross vehicle weight rating (GVWR) up to and including 24,000 pounds (lb). Vehicles such as the High Mobility Multipurpose Wheeled Vehicle (HMMWV), Joint Light Tactical Vehicle (JLTV), commercial sport utility vehicles (SUVs), and pickup trucks would fall under this category.

b. Wheeled Medium: Wheeled vehicles with a GVWR of 24,001 lb up to and including 60,000 lb. Vehicles in the Family of Medium Tactical Wheeled Vehicles (FMTV), Medium Tactical Vehicle Replacement (MTVR), or other medium commercial off-road vehicles would fall under this category.

c. Wheeled Heavy: Wheeled vehicles with a GVWR of 60,001 lb and greater. Vehicles such as the Heavy Expanded Mobility Tactical Truck (HEMTT), Palletized Load System (PLS), Logistical Vehicle System Replacement (LVSR), and other heavy commercial off-road vehicles would fall under this category.

d. Mine Resistant Ambush Protected (MRAP) / Route Clearance Vehicle (RCV). Special purpose armored trucks used for transporting personnel, light cargo, and mission specific equipment into operations. Typical vehicles include field ambulances, tactical unit transport, and explosive ordnance disposal.

e. Wheeled Truck Tractors and Trailers, Light and Medium: Truck-tractors and all compatible semitrailers. Vehicles such as the M1088 and MK31 truck-tractors, and M871/M872 semitrailers would fall under this category.

f. Wheeled Truck Tractors and Trailers, Heavy: Truck-tractors and all compatible semitrailers. Vehicles such as the M915, M916, M983, M1070, and MKR16 truck-tractors, and M870 (Medium Heavy Equipment Transporter), M1000 semitrailers would fall under this category.

g. Motorcycles: Single and dual wheel driven, all-terrain tires, and optional side-car and trailer.

h. Quad / All Terrain Vehicles (ATVs): Small four wheeled, single or dual axle driven all terrain vehicles with seating from one to four personnel.

i. Fire Trucks: Vehicles designed for fire fighting. These vehicles may have special equipment fitted on a standard, general purpose chassis, or may be a chassis solely dedicated to fire fighting. The main types covered are crash and rescue, brush, and structural.

j. Wheeled Combat: Wheeled vehicles serving in a direct combat role. Vehicles such as the Stryker and Light Armored Vehicle (LAV) would fall under this category.

NOTE: The vehicle mission profile listed in Table 1 is based from a combination of the Stryker and LAV profiles. An actual profile would need to be based from the vehicle mission and determined by the AST, Test Sponsor, and Test Officer.

k. Tracked Combat: Tracked vehicles serving in a direct combat role. Vehicles such as the Abrams Main Battle Tank and Bradley would fall under this category.

NOTE: The vehicle mission profile listed in Table 1 is an example from the Abrams profile. An actual profile would need to be based from the vehicle mission and determined by the AST, Test Sponsor, and Test Officer.

l. Tracked Support: Tracked vehicles serving the role of direct support to tracked combat vehicles, or tracked recovery vehicles. Vehicles such the M88 Recovery Vehicle and M113 Armored Personnel Carrier (APV) would fall under this category.

NOTE: The vehicle mission profile listed in Table 1 is an example from the Abrams profile. An actual profile would need to be based from the vehicle mission and determined by the AST, Test Sponsor, and Test Officer.

m. Robotics: Vehicle classes: Self Transportable and Appliqué. Missions for each class: Battle Space Awareness, Force Protection, Logistics, and Force Application. For all Missions in the Appliqué class, those systems will follow the OMS/MP of whatever system/vehicle they are installed on. For the Self Transportable class, the missions of Battle Space Awareness, Logistics, and Force Application will follow the OMS/MP of the platform, unit or convoy it is installed on or supporting.

n. Tracked Engineering: Tracked vehicles with the primary purpose of supporting construction missions. There are two basic categories of Tracked Engineering vehicles: steel tracked and rubber tracked. The region and soil type dictate the mission for each type of Tracked Engineering vehicle. Two profiles are provided to offer general guidance to follow for Endurance testing. A D7 Dozer and Hydraulic Excavator (HYEX) would fall under this category and have been used to establish a general profile for steel tracked engineering vehicles.

Vehicles such as the Skid Steer Loader (SSL) would fall under the rubber tracked engineering vehicle category.

o. Material Handling: Wheeled vehicle with the primary purpose of moving and transporting equipment. Vehicles such as the Rough Terrain Container Handler (RTCH) would fall under this category.

p. Wheeled Engineering: Wheeled vehicle with the primary purpose of supporting construction missions. The region and soil type dictate the mission for each type of Wheeled Engineering vehicle. A profile is provided to offer general guidance to follow for Endurance testing. Vehicles such as the High Mobility Engineer Excavator (HMEE) would fall under this category.

5.1.1 Terrain Definitions.

a. Vehicle specifications generally divide descriptions of road surfaces into four categories: primary roads, secondary roads, trails, and cross country. The specifications consist of a description of the particular surface and a range of Root Mean Square (RMS) roughness values associated with that surface. The descriptions are consistent throughout the wide spectrum of vehicles, but the RMS roughness values vary somewhat from vehicle to vehicle. The descriptions and suggested RMS roughness values are documented in TOP 01-1-010.

b. The RMS values given for each category of surface can be misleading. The response of a vehicle to surface roughness is dependent upon the shape of the wave number spectrum (WNS), the dynamic responsiveness of the particular vehicle and the vehicle speed. Two different WNS can have the same RMS value. Therefore, having equivalent RMS roughness values does not imply that two test courses will produce equivalent test results.

c. An example where course description and RMS value contradict each other would be the Perryman No. 1 Course at ATC. Although it's listed RMS value would categorize it as a secondary road, this course is used as a trail for endurance testing. This classification is based on historical precedence and the verbal description of the terrain type.

d. In addition, testing should also include a mix of level and hilly courses. Test scenarios should include stops, changes of direction, and/or obstacle avoidance to exercise brakes, steering, driveline locks, and transmission frequently throughout endurance testing. Based on lessons learned from operational areas, endurance testing could include simulated stream crossings (fording), traversing mud, and intermittent operations on side slopes for added realism for each type of vehicle, if applicable. For some types of vehicles this would include operations in simulated urban areas. ATC and YTC both have Urban Terrain courses. TOP 01-1-011A contains a full description of the Urban Terrain course located at ATC.

5.1.2 Tire Pressure Settings.

It is recommended that all vehicles have their tire pressures set in accordance with (IAW) the vehicle manufacturers recommended setting for specific terrains. If equipped with a central tire

inflation system (CTIS), those settings should be used for specific terrains. If no guidance is provided, vehicles generally operate on primary and secondary roads using a "highway" tire pressure setting. Vehicles operating on trails or cross country terrains will generally use a "cross-country" tire pressure setting.

5.1.3 Suspension Settings.

It is recommended that vehicles equipped with selectable suspension modes be used for each specific terrain on which they are operated. Different suspension modes could be further selected based on the course conditions for a given day of testing; e.g., the "gravel" mode could be used during dry days and the "mud" mode be used on wet days.

5.1.4 Endurance Profile Samples.

a. The total mileage required for a particular test is usually dictated by the test customer or called out in the AEC Test Execution Directive. By applying the percentage of each terrain required along with the total test mileage to be accrued, the number of miles per test course can be calculated. Table 2 is a blank table that can be filled in with what specific courses will be used to generate the total mileage required for a particular endurance test.

TABLE 2. ENDURANCE MILEAGE BREAKDOWN BY COURSE (BLANK)

	B	C	D	E	F
TERRAIN TYPE	OMS/MP TERRAIN PERCENT	TERRAIN TYPE TOTAL MILEAGE, mi	TEST COURSE	COURSE PERCENT	COURSE TOTAL MILEAGE, mi
Primary					
Secondary					
Trails/Rough Trails					
Cross-Country					
TOTAL	----------	A	----------	----------	----------

b. To fill in the table, the total required mileage should be input into the block labeled A. Next, the OMS/MP Terrain Percentages should be input into the blocks for the column labeled B. Next, choose the vehicle group type for the test item, and transpose the required courses and terrain type percentages for the particular test location for the column labeled D and E. The Terrain Type Total column (labeled C) can then be calculated by multiplying the total required mileage (block A) by the OMS/MP percentages (values in each of the blocks in column B). The Course Total Mileage (column F) total can then be calculated by multiplying each of the Terrain Type Total (column C) values by the Course Terrain Type Percent (column E) values. As an example, Table 3 is a completed table for a light wheeled vehicle being tested at YTC for 20,000 miles using a 30% Primary Roads, 30% Secondary Roads, 20% Trails, and 20% Cross Country Terrain Profile.

NOTE: If the OMS/MP does not provide a value for Trails/Rough Trails but does include Cross-Country, the Cross-Country percentage should be equally divided between both in column B.

TABLE 3. ENDURANCE MILEAGE BREAKDOWN BY COURSE, LIGHT WEIGHT VEHICLE AT YTC

	B	C	D	E	F
TERRAIN TYPE	OMS/MP TERRAIN PERCENT	TERRAIN TYPE TOTAL MILEAGE, mi	TEST COURSE	COURSE PERCENT	COURSE TOTAL MILEAGE, mi
Primary	30	6,000	Laguna Paved	100	6,000
Secondary	30	6,000	Patton Level Gravel	35	2,100
			Patton Hilly Gravel	30	1,800
			Kofa Level Gravel	35	2,100
Trails/Rough Trails	20	4,000	Patton Level Trails	60	2,400
			Desert March[a]	40	1,600
Cross-Country	20	4,000	Desert March[a]	50	2,000
			Rock Ledge	10	400
			Middle East	40	1,600
TOTAL	----------	20,000	----------	----------	20,000

[a] 44% has been classified as Trails/Rough Trails- and 56% of Desert March has been classified as Cross Country Terrain. For each, complete North to South or South to North Traverse, these percentages (44% and 56%) should be applied to calculate the respective terrain types.

c. After the total mileage by course type is computed, test cycles can be designed. Test cycles are typically 1,000-3,000 mile intervals for wheeled vehicles and 50-100 miles for each mission for tracked vehicles (dependant on vehicle and mission). All mileage should be accumulated and all operations completed for a particular test cycle before a subsequent test cycle is initiated. If test cycles are not used, mileage should be accumulated in a manner that maintains the percentages of the overall endurance mileage breakdown throughout the test.

5.1.5 Course Speeds and Jury Ride Procedure.

a. Maintain speeds that have been provided from the Test Plan, Test Officer, vehicle manufacturer, or Test Sponsor. If no guidance has been provided, follow the course speed limits, and maintain safe and practical speeds for the particular course conditions. Perform a Jury Ride and follow-on data analysis, to the extent support personnel are available and budgeted for, and maintain the speeds identified during the Jury Ride process.

b. The purpose of a Jury Ride is to establish a common definition and understanding of the severity levels a vehicle can be subjected to on a specific course and establish parametric values for each course from the measured sensor data when the vehicle is driven at three severity levels (e.g,. Low, Normal, and High). Establishing these parameters will identify acceptable speeds and other appropriate parameters (e.g., suspension displacement and acceleration) for use to establish bounds and maintain a method of consistency throughout endurance testing. Acceptable operating limits will be established for each test course and each measured parameter independently as described in the following paragraphs. The same analysis will be performed on a daily basis during endurance testing for each vehicle for each test course, and those results will be compared to the Jury Ride pre-established limits to ensure operation within acceptable bounds. Establishing the Low and High parametric values will help determine how significant the difference is between the daily values and the desired Normal values. As a minimum, sensors and instrumentation should be installed to measure vehicle speed, suspension displacement, and/or suspension acceleration at one vehicle corner. Other parameters to consider (but are not limited to) are: engine speed, electrical load, suspension displacement and acceleration at an opposite corner, driver's vertical ride quality (TOP 01-1-014A[13]) based on a seat frame input instead of a ride quality pad, percent engine load, and percent throttle position.

c. On-vehicle digital recording instrumentation will be used to record the required parameters. The sample rate and filtering will be appropriate for each parameter sampled. Before conducting a Jury Ride, the following instructions should be understood by the driver to describe how they should drive for each severity level:

(1) High Severity: Drive in a manner which allows the fastest negotiation of the test course, while maintaining full control of the vehicle and maintaining a safe posture at all times.

(2) Normal: Drive as though an entire day of driving on the specific test course is required, but with no atypical urgency. An objective speed should also be suggested, though the vehicle response may indicate a need to drive at a different speed.

(3) Low Severity: Drive as though the most important aspect of a mission is its completion.

d. The establishment of the jury ride vehicle response measurements will initially be conducted by the Test Officer and other appropriate test center personnel. Before the Jury Rides, the Jury Drivers should operate the vehicles on the designated test courses to gain a sense of the handling and responsiveness of the different vehicles. One purpose of this is to minimize the time, error and variation caused by the driver becoming familiar with the truck on the day of the Jury Ride. On the day of the Jury Ride, the jury will ride on the designated test courses, in a specific vehicle, prior to conducting the first assessment. This gives the jury the opportunity to acclimate to the vehicle and gain an understanding of the vehicle responses on the designated courses. For every assessment lap, the jury will fill out a Jury Ride questionnaire. Scoring committee members are encouraged to participate in the jury pool.

e. The vehicle and trailers (if applicable) shall be configured and loaded IAW the project Test Plan. For tests that have multiple payloads, trailers and/or vehicle configurations, assessment is required to identify which configurations should be subjected to a Jury Ride in order to adequately quantify and bound acceptable vehicle operating parameters. A method to identify which configurations should be subjected to a Jury Ride would be to conduct a Jury Ride at vehicle curb weight (VCW), gross vehicle weight (GVW) and gross combination weight (GCW) (if applicable). The process shall be repeated and documented for each payload configuration required. If necessary, at least two operators will be used in the jury ride process and they should have experience with similar vehicles.

f. For comparison testing between vehicles, there should be some degree of commonality between the jurors used in each vehicle. The commonality could be achieved by using the same jurors or through training and discussions, to arrive at common definitions of severity, or some combination of both methods. A common definition and understanding of severity levels by the jurors is important because test results from two vehicles could differ significantly if they are permitted to be tested at different severity levels. Another purpose for commonality amongst jurors is to provide an opportunity to assess common operational objectives, such as average speed on course. Common operational objectives should be known before the day of the Jury Ride. All compared vehicles should be driven by at least one common driver to assure the same operational objectives are met. Details of Jury Ride procedures, controls, and cautions are continued in Appendix B.

5.1.6 Towed Loads.

Each vehicle tows its designated load as dictated by the test customer or called out in the AEC Test Execution Directive. Payloads for both towing and towed vehicles typically include no load, half load, and full load and may include any allowable overload determined by special tests.

5.1.7 Maintenance and Inspections.

Perform preventive (scheduled) maintenance as prescribed in the applicable TM and perform corrective (unscheduled) maintenance as required to keep the vehicle operational. Collect fluid samples during scheduled services for analysis to monitor for any component degradation or fluid contamination. If the endurance profile has been shortened to a mileage that would not require regular scheduled services, then consider fluid sample collection at the beginning, middle, and end of testing. Recommended areas for fluid sampling would be from the engine, transmission, hubs, differentials, transfer case, hydraulic oil and reservoirs, and coolants. Observe the operator's daily PMCS to obtain a representative time to perform the tasks. Record all maintenance action data pertinent to RAM parameters, including scheduled and unscheduled maintenance time in man-hours and clock-hours. In addition to all required operator level PMCS, inspect all components not included in the daily TM PMCS on the test item at least once per shift of operations for deficiencies, damage, or unusual wear. If a tire is replaced during testing, measure the tread depth of the worn/failed tire and compare to the measurements collected during the initial inspection. Measure the tread depth of the new tire for comparison to the Final Inspection measurements.

5.1.8 Spectrometric Oil Analysis.

When the compatibility of fuels and lubricants with the test vehicle is to be evaluated, take lubricant samples during the test for a spectrometric oil analysis in accordance with TOP 02-2-690.

5.1.9 Modifications.

Incorporate engineering modifications as required to eliminate causes of damage or undue wear to the vehicle as soon as practical. Obtain written concurrence from the test sponsor before applying or installing any modification. Consider restarting Endurance testing or increasing the scope of the test so the vehicle can accumulate mileage with modifications applied, if agreed upon by the test sponsor and AST. Each modification shall be documented in a TIR to track the vehicle configuration under test. The TIR shall include sufficient details regarding the modification and all component changes to properly identify the configuration change to the test vehicle.

5.1.10 Equipment Operations.

Test scenarios should include actual on-the-move operation of turret and onboard systems and equipment. Combat vehicle missions are conducted with the turret active (all systems operating) and the turret in motion. All ancillary equipment and ASIOE should be used and cycled an amount commensurate with the expected real time operation of the vehicle when compared to the numbers of endurance miles accrued. If applicable, an electrical load bank can be added to a test item to properly test onboard electrical equipment (e.g., radios, jammers, etc.) and to apply a sufficient load on the vehicles alternator if all equipment is not present on the test item. Items such as winches, radios, nuclear, biological, and chemical (NBC) detectors, situational awareness

indicators, vehicle tracking systems, material handling equipment, load handling equipment, trailer coupling/uncoupling, weapons firing, lift/tow (wreckers), landing gear (trailers), and fifth wheels (truck tractors) should all be used and exercised as applicable and for a number of cycles or duration that equates to a time representative of the endurance test mileage accumulated. Consult with the combat developer for guidance when to perform equipment operations if not defined in the Purchase Description or OMS/MP.

5.1.11 Special Tests.

When required, conduct special tests on specific components during endurance testing, such as headlight, engine or transmission tests, etc. Interior crew compartment noise tests, using guidance in TOP 01-2-608A[14], should be conducted prior to the start of the test to determine if hearing protection for the driver and crew members is required. Noise testing should be repeated at the end of the endurance test if the initial data reveals levels close to the single protection level of 85 dB(A) or double protection requirement of 103 dB(A) to determine if the sound suppression material applied to the vehicle has degraded.

5.1.12 Final Inspection.

At the conclusion of testing, disassemble the vehicle to the extent required for visual and dimensional inspections of unusual wear or damage to components. Record the results using photographs to show the wear and condition of major components. Collect fluid samples for analysis to determine post testing internal wear and to compare against previously collected samples. Measure the tread depth of the tires for comparison to the Initial Inspection and during-test tire change measurements.

5.2 Data Required.

a. Insofar as practicable, collect test data on a continuing basis using standard forms and TIRs for recording events and distance over the various courses. TIRs should be written following Department of the Army Pamphlet (DA PAM) 73-1, Appendix V[15]. Generate an individual TIR for each anomaly found during the conduct of the Endurance test, to include problems revealed and not corrected during operations, and problems resolved with a maintenance action. Document any problems, safety hazards, and modifications with photos as appropriate.

b. Record the following, as applicable:

(1) Initial and final odometer readings and miles traveled.

(2) Vehicle speed on each course.

(3) Total engine hours.

(4) Component operational hours.

(5) Vehicle fuel consumption (TOP 02-2-603A[16]).

(6) Quantity and type of engine oil, lubricants, and coolant used.

(7) Vehicle configuration changes, e.g. testing with different payloads.

(8) Tire pressure adjustments for terrain changes (if applicable).

(9) Component failures and failure analysis.

(10) Parts mortality data.

(11) Required component adjustments.

(12) Environmental conditions, e.g., road, weather, etc.

(13) RAM-D data IAW the AEC Test Execution Directive or customer test requirements, as specified. Provide all the information required by the forms contained in AR 750-1[17] for each maintenance action such as odometer reading, vehicle hours, man-hours, maintenance level, part failure, scheduled/unscheduled, personnel involved, action required, etc. Collected data should be sufficient to conduct analysis IAW TOP 01-1-030.

(14) Human factors observations. (All information required by AR 602-1[18]).

(15) Results of spectrometric oil analysis.

(16) Tire wear data (TOP 02-2-704) (if applicable).

(17) Data on additional requirements for applicable vehicle group.

(18) Results of final inspection.

(19) Any safety hazards noted.

(20) Failure descriptions and analysis should include all information available for the determination of causes of failures, if readily known from testing, especially failure due to environmental or usage factors (e.g., heat, mud, dust). This information can be used by the contractor to determine the root cause of failures.

(21) Include the season of year the test was conducted and if climate during the test was different from the norm (e.g., the climate was either drier or wetter than normal when the test was conducted).

(22) Modifications installed.

6. PRESENTATION OF DATA.

a. Summarize all data to identify significant deficiencies and shortcomings and overall fuel and lubricant consumption. Calculate overall fuel consumption for each vehicle configuration, when required.

b. Present data of paragraph 5.2 in graphical and/or tabular form when required.

c. Prepare charts and graphs to show operation versus maintenance time, component failures, part mortality, etc. (For guidance in calculating and presenting maintenance data see AR 750-1 and TOP 01-1-030.)

d. Carefully analyze the adequacy of any modification made to the vehicle, since modifications in most cases are incorporated during the course of testing and will not undergo the full vehicle test mileage. In the case of critical modifications or those installed late in the test program, it may be necessary to recommend that additional tests or a retest be conducted to determine whether the modifications are suitable.

e. A sample Jury Ride questionnaire, and sample plot of mean road speed, caution, and control bounds, are included in Appendix B.

(This page is intentionally blank.)

TABLE A-1. VEHICLE GROUP TERRAIN TYPE, PERCENT PER COURSE

TERRAIN TYPE	LOCATION	COURSE NAME	W-L	W-M	W-H	MRAP/ RCV	LM-TT	H-TT	M	QUAD/ ATV	FT
Primary Roads (Paved Highway)	ATC	ATEF Paved	100	100		50			100	100	
		Perryman Paved			100	50	100	100			100
	YTC	Laguna High Speed Paved Oval	100	100	100	100	100	100	100	100	100
Secondary Roads	ATC	ATEF Gravel	15	15			10				50
		Munson Gravel Course	15	15	35	30	15	20		60	
		Belgian Block[A]	10	10	10		5	10	100	40	
		Perryman A		30	30		30	30			
		Perryman No. 1 Course[B]	30			70					
		Churchville C Course	30	30	25		40	40			50
	YTC	Patton Level Gravel	35	35	35	35	30		20	30	35
		Patton Hilly Gravel	30	30	25	30	20		40	40	30
		Kofa Level Gravel	35	35	40	35	50	100	40	30	35
Trails/Rough Trails[C]	ATC	Belgian Block				20					
		Perryman No. 1 Course[B]		20	20		40	60			
		Perryman No. 2 Course	60	50	50	40	60	40		50	90
		Churchville B Course	40	30	30	40			100	50	10
	YTC	Laguna Level Trails East					80	100			80
		Laguna Level Trails West		20	40				40		
		Laguna Hilly Trails	10	10	10	40	20			30	20
		Patton Level Trails	50	40	20				20	40	
		Patton Hilly Trails				40					
		Desert March[D]	40	30	30	20			40	30	
Cross-Country	ATC	Churchville A Course							90	80	
		Perryman No. 3 Course	95	100	100	100			10	10	
		Perryman No. 4 Course									
		Perryman No. 5 Course	5							10	
	YTC	Desert March[D]	50	50	50	50					
		Rock Ledge	15	15	15	10					
		Middle East	35	35	35	40					
		Patton Level Trails									
		Patton Hilly Trails									

LEGEND:
W-L = Wheeled Light
W-M = Wheeled Medium
W-H = Wheeled Heavy
LM-TT = Light/Medium Truck
H-TT = Heavy Truck Tractor/Trailer
M = Motorcycle
FT = Fire Truck

TABLE A-1. CONTINUED

TERRAIN TYPE	LOCATION	COURSE NAME	W-C	R	TRK-C	TRK-S	TE-S	TE-R	W-E	MH
Primary Roads (Paved Highway)	ATC	ATEF Paved	100						50	
		Perryman Paved			100	100	100	100	50	100
	YTC	Laguna High Speed Paved Oval	100							
Secondary Roads	ATC	ATEF Gravel			100	100	100	100	100	100
		Munson Gravel Course	30			50				
		Belgian Block[A]	10		50					
		Perryman A	30	100		50				
		Perryman No. 1 Course[B]			50					
		Churchville C Course	30							
	YTC	Patton Level Gravel	35	50	100	100	100	100	35	35
		Patton Hilly Gravel	30						30	30
		Kofa Level Gravel	35	50					35	35
Trails/Rough Trails[C]	ATC	Belgian Block								
		Perryman No. 1 Course[B]	40				30	30	30	30
		Perryman No. 2 Course	30	45	50	50	35	35	35	35
		Churchville B Course	30	55	50	50	35	35	35	35
	YTC	Laguna Level Trails East								
		Laguna Level Trails West							40	40
		Laguna Hilly Trails	20						10	10
		Patton Level Trails	40	45	50	50	50	50	20	20
		Patton Hilly Trails		55	50	50	50	50		
		Desert March[D]	40						30	30
Cross-Country	ATC	Churchville A Course								
		Perryman No. 3 Course	50	100	50	50	90	90	90	100
		Perryman No. 4 Course	50		50	50	10	10	10	
		Perryman No. 5 Course								
	YTC	Desert March[D]	50						50	50
		Rock Ledge	10							
		Middle East	40	100					40	
		Patton Level Trails			50	50	50	50		
		Patton Hilly Trails			50	50	50	50	10	50

LEGEND:
W-C = Wheeled Combat
TRK-C = Tracked Combat
TRK-S = Tracked Combat Support
R = Robotic
TE-S = Tracked Engineering - Steel
TE-R = Tracked Engineering - Rubber
WE = Wheeled Engineering
MH = Material Handling

APPENDIX A. ENDURANCE COURSES BY TERRAIN WITH COURSE

TABLE A-1 NOTES:

A Although the RMS value exceeds that of a secondary road, this course is used in conjunction with Munson Gravel as a secondary road for endurance testing. This classification is based on historical precedence and the verbal description of the terrain type. (TOP 01-1-010)

B Although the RMS value is less than that of a trail, this course is used as a trail for endurance testing. This classification is based on historical precedence and the verbal description of the terrain type. (TOP 01-1-010)

C If Trails and Rough Trails are called out in the OMS/MP, combine the percentages to calculate the total miles, and then use the course percentages as listed.

D Desert March has been classified as 44% Trails/Rough Trails and 56% has been classified as Cross Country Terrain. For each, complete North to South or South to North Traverse, these percentages (44% and 56%) should be applied to calculate the perspective terrain types.

(This page is intentionally blank.)

APPENDIX B. JURY RIDE PROCEDURE, CONTROLS AND CAUTIONS.

B.1 JURY RIDE PROCEDURE.

a. A separate Jury Ride assessment should be completed for each individual course. The intended purpose of the test course should be considered when making the assessments.

b. High, Normal, and Low Severity parametric values should be established for each vehicle for each course.

c. For every assessment lap, each Juror should complete a Jury Ride questionnaire. For convenience, the Jury Ride questionnaire can be subdivided for each distinct assessment. A sample Jury Ride questionnaire is shown in Figure B-1.

d. The Jury Ride questionnaire should address different aspects of vehicle stressors that a Juror could plausibly assess. Example categories include:

(1) Average Speed.

(2) Overall Roughness.

(3) Frequency of Transient Events.

(4) Harshness of Events.

e. The categories should be rated on a scale of 1 to 10. A Low Severity run would be represented by values 1 to 3; a Normal Severity run represented by values 4 to 7; and a High Severity run represented by values 8 to 10.

f. The limitations of course conditions on the day of the Jury Ride and the dynamics of the vehicle could lead to situations where some categories are assessed differently than others within a single lap. For example, on the day of the Jury Ride, the course may be in a smoother condition preventing an opportunity to assess a High Severity rating for Frequency of Transient Events. In such a case, the Juror assessments should not be artificially inflated, but rather represent their opinion of the lap severity given the intended purpose of the test course. The numerical ratings would be useful to determine if the parametric bounds derived from the Jury Ride need to be adjusted during the RAM test.

g. Ideally the intended nominal severity (Low, Normal, or High) should not be known or announced prior to a lap. The driver should drive with an objective to represent a severity level, in his/her opinion, but that intended severity level should not be discussed until after the lap is complete and Jurors have made their own assessment.

APPENDIX B. JURY RIDE PROCEDURE, CONTROLS AND CAUTIONS.

Juror Name:			Date:		Time:	
Juror Seat Location:	Driver	Front Pass.	Rear Left Pass.	Rear Right Pass.	(circle)	
Driver Name:			Configuration:		Trailer (Y/N)	
Vehicle Identification:	Lap Description		Severity	Lap Description		Severity
Course Name(s):						
Severity	Low	Normal	High			
Ratings	*1 to 3, 2 best*	*4 to 7, 5.5 best*	*8 to 10, 9 best*			
Juror's Review:	*Scoring higher or lower, from best, indicates approaching other Objective*					
Speed and Handling	Rating(s)					
	Course-lap	Course-lap	Course-lap	Course-lap	Course-lap	Course-lap
Average Speed (1-10):						
Speed in Straightaway (1-10):						
Speed in Turns (1-10):						
Comments:						
Roughness of Occupant Ride	Rating(s)					
Overall Roughness (1-10):						
Comments:						
Transient events	Rating(s)					
Frequency of Events (1-10):						
Harshness of Events (1-10):						
Comments:						
Power Train Loading, Shifting	Rating(s)					
Loading overall (1-10):						
Loading on grades (1-10):						
Comments:						
Overall Rating:						

Figure B-1. Sample Jury Ride Questionnaire

APPENDIX B. JURY RIDE PROCEDURE, CONTROLS AND CAUTIONS.

h. The Jurors should then discuss their assessments. If the Jury comes to an agreement that the lap sufficiently represented the desired severity level (Low, Normal, and High), the recorded data from that lap should be used to establish the parametric values representing the severity level for that course.

i. The most important point is for the Jury to reach a majority agreement that the data recorded during that run could represent a high, low, or normal severity level for that course. If time permits, multiple laps at each severity level should be repeated to increase confidence.

B.2 ESTABLISH PARAMETRIC DATA CAUTION AND CONTROL ZONE BOUNDS.

a. The purpose of the Caution and Control Zone parameters is to help maintain consistency throughout the test. For this reason, the data acquisition and post-processing techniques used to establish the boundary parameters need to be comparable to those used to generate the daily parameters. A data source could be an installed sensor or a data channel from the vehicle Bus. The most relevant characteristic of the data source is consistency. All data comparisons are relative comparisons for the same data source on the same vehicle.

b. The daily statistical parameters of sensor data from endurance testing on a particular course will be compared to Caution and Control Zone bounds determined from the sensor data recorded during the Jury Ride. The comparison between the daily statistical parameters and the established bounds will be informative to evaluate the inputs from the driver, course conditions, and vehicle conditions. The comparison of the daily responses to the boundaries will help determine the guidance to provide the drivers, course maintenance crew, and/or vehicle mechanics.

c. During endurance testing, data will be recorded continuously throughout the day, with each file recorded for specific durations (15 to 30 minutes) before initiating a new file. To ensure that the data parameters are not skewed by the vehicle being stopped (due to various reasons), the data will only be analyzed for time periods when the vehicle speed is greater than 3 miles per hour.

d. Speed Bounds. The speed bounds used for a test should be reasonable for the test item. To facilitate agreement and expedite the process of determining appropriate bounds, any calculation method can be adopted. The following method is an example of determining speed bounds. For each course, the lower Caution Zone Bound will be the average speed from the lowest Low Severity run. The upper Caution Zone Bound will be the average speed from the highest High Severity run. The lower Control Zone Bound will be the lower Caution Zone Bound, minus 10-percent of the average of the lower and upper Caution Zone Bounds. The upper Control Zone Bound will be the upper Caution Zone bound, plus 10-percent of the average of the lower and upper Caution Zone bounds. When data shifts are detected, or when it falls

within the caution zones or outside of control zones, the test officer and/or engineering judgment will be utilized to determine what, if any, appropriate corrective actions are warranted. A sample plot of Mean Road Speed and Caution and Control Bounds for a specific course is presented in Figure B-2.

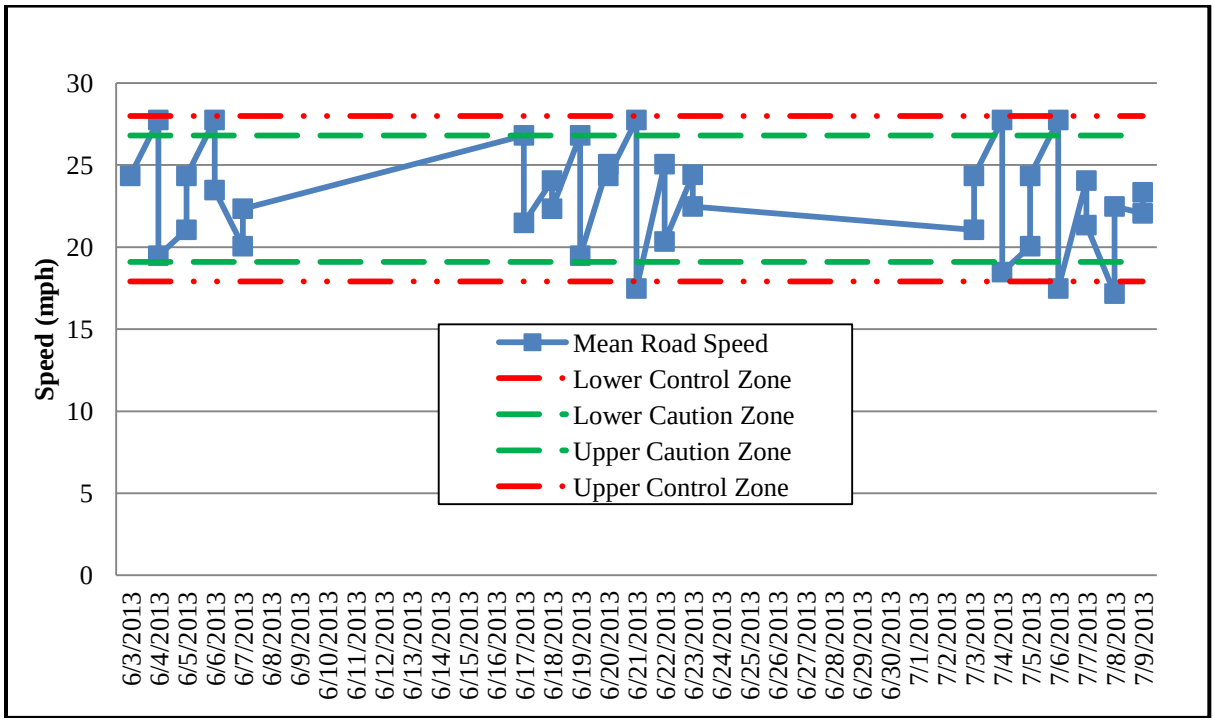

Figure B-2. Mean road speed and caution and control bounds.

e. 90-Percent Range Bounds.

(1) A 90-Percent Range value is a parameter that represents the distribution of data for a data channel. It is found by first determining the data distribution values which are respectively greater than 5- and 95-percent of the data. The 90-Percent Range value is the difference between the 95- and 5-percent distribution values. The advantage of the 90-Percent Range value is that focusing on the range can negate the influence of erroneous data channel offsets that can be introduced throughout a test day. The final 90-Percent Range value will be the average of all 90-Percent Range values calculated from 30-second windows, for a particular course.

APPENDIX B. JURY RIDE PROCEDURE, CONTROLS AND CAUTIONS.

(2) The parametric bounds used for a test should be reasonable for the test item. To facilitate agreement and expedite the process of determining appropriate bounds, any calculation method can be adopted. The following method is an example of determining appropriate bounds. For a specific data channel on a particular course, the lower Caution Zone 90-Percent Range Bound will be the 90-Percent Range value from the Low Severity run. The upper Caution Zone 90-Percent Range Bound will be the 90-Percent Range value from the High Severity run. The lower Control Zone Bound will be the lower Caution Zone Bound, minus 10-percent of the average of the lower and upper Caution Zone Bounds. The upper Control Zone Bound will be the upper Caution Zone bound, plus 10-percent of the average of the lower and upper Caution Zone bounds. A sample plot of the Left Front Suspension Acceleration 90-Percent Range Values and Caution and Control Bounds for a specific course is presented in Figure B-3.

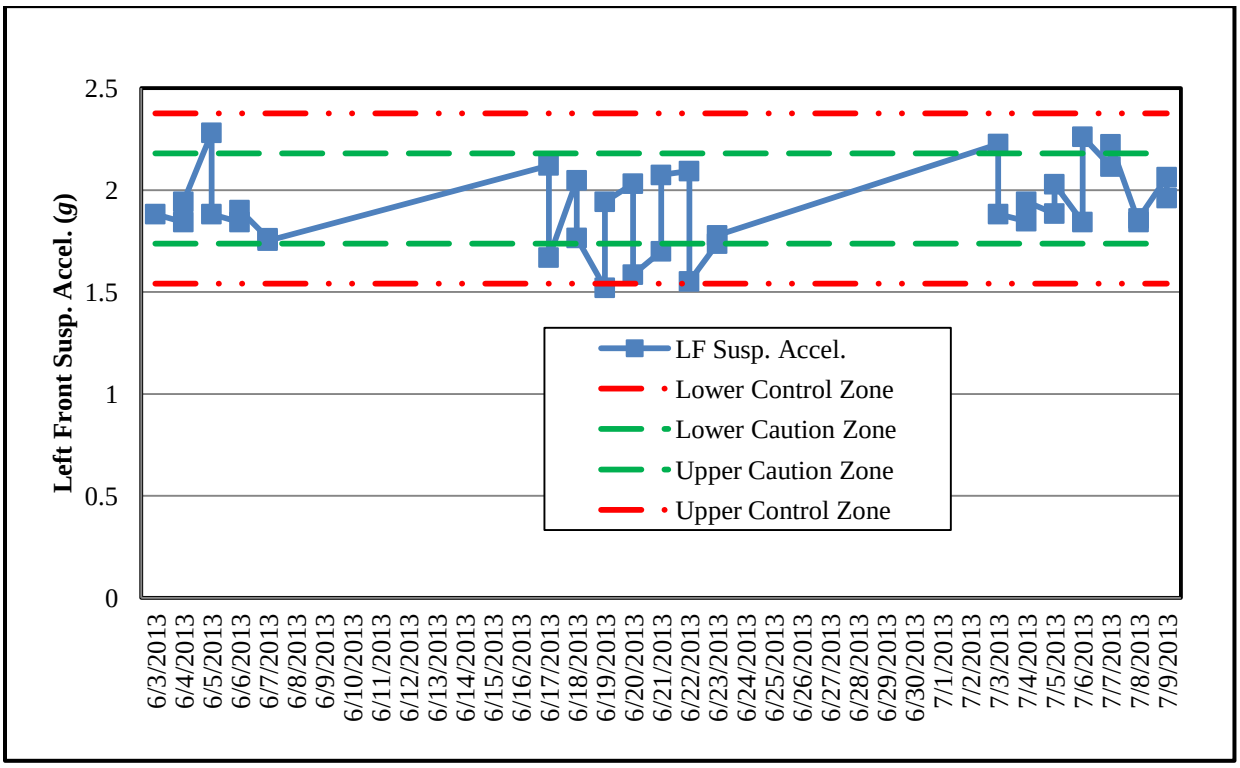

Figure B-3. Suspension acceleration, 90-percent range values, cautions and bounds.

(This page is intentionally blank.)

APPENDIX C. ABBREVIATIONS.

AEC	U.S. Army Evaluation Center
APV	Armored Personnel Carrier
AR	Army Regulation
ASIOE	associated support in other equipment
AST	U.S. Army Test and Evaluation Command System Team
ATC	U.S. Army Aberdeen Test Center
ATEC	U.S. Army Test and Evaluation Command
ATV	All Terrain Vehicle
BII	basic issue items
C	Celsius
CANBUS	controller area network bus
COTS	commercial off the shelf
CTIS	central tire inflation system
dB	decibel
DA PAM	Department of the Army Pamphlet
DAQ	data acquisition
F	Fahrenheit
FMTV	Family of Medium Tactical Wheeled Vehicles
GCW	gross combination weight
GVW	gross vehicle weight
GVWR	gross vehicle weight rating
HEMTT	Heavy Expanded Mobility Tactical Truck
HMEE	High Mobility Engineer Excavator
HMMWV	High Mobility Multipurpose Wheeled Vehicle
HYEX	Hydraulic Excavator
IAW	in accordance with
ILS	integrated logistics supportability
IOP	Internal Operating Procedure
JLTV	Joint Light Tactical Vehicle
LAV	Light Armored Vehicle
lb	pound
LVSR	Logistical Vehicle System Replacement

APPENDIX C. ABBREVIATIONS.

MIL-STD	Military Standard
MRAP	Mine Resistant Ambush Protected
MTVR	Medium Tactical Vehicle Replacement
NBC	nuclear, biological, and chemical
NET	new equipment training
OMS/MP	Operational Mode Summary/Mission Profile
PLS	Palletized Load System
PMCS	preventive maintenance checks and services
RAM-D	reliability, maintainability, durability
RCV	Route Clearance Vehicle
RMS	Root Mean Square
RTCH	Rough Terrain Container Handler
SAR	Safety Assessment Report
SOP	Standing Operating Procedure
SR	Safety Release
SSL	Skid Steer Loader
SUV	sport utility vehicle
TACOM	U.S. Army Tank-Automotive and Armaments Command
TIIN	test item identification number
TIR	Test Incident Report
TM	Technical Manual
TOP	Test Operations Procedure
TSARC	Test Schedule and Review Committee
VCW	vehicle curb weight
WNS	wave number spectrum
YPG	Yuma Proving Ground
YTC	U.S. Army Yuma Test Center

APPENDIX D. REFERENCES.

1. TOP 01-2-502, Durability, 19 December 1984.

2. TOP 01-1-011A, Vehicle Test Facilities at Aberdeen Test Center and Yuma Test Center, 27 February 2012.

3. TOP 01-1-030, RAM-D and ILS Analysis, 8 September 2008.

4. TOP 01-1-010 with CN1, Vehicle Test Course Severity, 4 January 2012.

5. TOP 02-2-505, Inspection and Preliminary Operation of Vehicles, 4 February 1987.

6. TOP 02-2-704, Tires, 23 January 1976.

7. TOP 02-2-690, Army Oil Analysis Program for Vehicle Testing, 16 August 1996.

8. MIL-STD-1366E, Interface Standard for Transportability Criteria, 31 October 2006.

9. ATC IOP 385-0010, Internal Vehicle Payloading, 22 February 2012.

10. TOP 02-2-508, Automotive Safety and Health Hazard Evaluation, 24 November 1982.

11. AR 70-38, Research, Development, Test and Evaluation of Materiel for Extreme Climatic Conditions, 15 September 1979.

12. TOP 01-1-065, Accelerated Corrosion Durability, 15 October 2013.

13. TOP 01-1-014A with CN1, Ride Dynamics and Evaluation of Human Exposure to Whole-Body Vibration, 3 April 2012.

14. TOP 01-2-608A, Sound Level Measurements, 1 August 2011.

15. DA PAM 73-1, Test and Evaluation in Support of Systems Acquisition.

16. TOP 02-2-603A, Vehicle Fuel Consumption, 10 May 2012.

17. AR 750-1, Army Materiel Maintenance Policy, 12 September 2013.

18. AR 602-1, Human Factors Engineering Program, 8 February 1991.

(This page is intentionally blank.)

APPENDIX E. APPROVAL AUTHORITY.

CSTE-TM 2 October 2014

MEMORANDUM FOR

Commanders, All Test Centers
Technical Directors, All Test Centers
Directors, U.S. Army Evaluation Center
Commander, U.S. Army Operational Test Command

SUBJECT: Test Operations Procedure (TOP) 02-2-506A, Wheeled and Tracked Vehicle Endurance Testing, Approved for Publication

1. TOP 02-2-506A, Wheeled and Tracked Vehicle Endurance Testing, has been reviewed by the U.S. Army Test and Evaluation Command (ATEC) Test Centers, the U.S. Army Operational Test Command, and the U.S. Army Evaluation Center. All comments received during the formal coordination period have been adjudicated by the preparing agency. The scope of the document is as follows:

This TOP describes procedures for conducting endurance tests of wheeled and tracked vehicles over various standard test courses for prescribed distances or times. Endurance testing involves extended operation of one or more test vehicles under cycles designed to simulate extended field use under proving ground conditions. The endurance test is the principle means of producing data for reliability and maintainability during development tests.

2. This document is approved for publication and has been posted to the Reference Library of the ATEC Vision Digital Library System (VDLS). The VDLS website can be accessed at https://vdls.atc.army.mil/.

3. Comments, suggestions, or questions on this document should be addressed to U.S. Army Test and Evaluation Command (CSTE-TM), 2202 Aberdeen Boulevard-Third Floor, Aberdeen Proving Ground, MD 21005-5001; or e-mailed to usarmy.apg.atec.mbx.atec-standards@mail.mil.

FONTAINE.RAYMOND.G.1228612770
Digitally signed by FONTAINE.RAYMOND.G.1228612770
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=FONTAINE.RAYMOND.G.1228612770
Date: 2014.10.09 12:12:36 -04'00'

MICHAEL J. ZWIEBEL
Director, Test Management Directorate (G9)

(This page is intentionally blank.)

Forward comments, recommended changes, or any pertinent data which may be of use in improving this publication to the following address: Range Infrastructure Division (CSTE-TM), U.S. Army Test and Evaluation Command, 2202 Aberdeen Boulevard, Aberdeen Proving Ground, Maryland 21005-5001. Technical information may be obtained from the preparing activity: Automotive Directorate (TEDT-AD), US Army Aberdeen Test Center, 400 Colleran Road, Aberdeen Proving Ground, MD 21005-5059. Additional copies can be requested through the following website: http://www.atec.army.mil/publications/topsindex.aspx, or through the Defense Technical Information Center, 8725 John J. Kingman Rd., STE 0944, Fort Belvoir, VA 22060-6218. This document is identified by the accession number (AD No.) printed on the first page.